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EXAMINER
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BEFORE THE BOARD OF PATENT APPEALS  
AND INTERFERENCES

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*Ex parte* THOMPSON M. SLOANE, PAUL M. NAJT, and  
WILLIAM R. LEPPARD

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Appeal 2010-001884  
Application 10,602,938  
Technology Center 3700

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Before JOHN C. KERINS, WILLIAM V. SAINDON and  
MICHAEL L. HOELTER, *Administrative Patent Judges*.

HOELTER, *Administrative Patent Judge*.

DECISION ON APPEAL

### STATEMENT OF THE CASE

This is a decision on appeal under 35 U.S.C. § 134(a), from a final rejection of claims 1-17 and 20-35<sup>1</sup>. The real party in interest is General Motors Corporation. We have jurisdiction under 35 U.S.C. § 6(b).

We affirm.

#### References Relied on by the Examiner

Bundrick	U.S. 4,419,969	Dec. 13, 1983
Ethington	U.S. 4,690,743	Sep. 1, 1987
Gonzalez	U.S. 4,765,293	Aug. 23, 1988
Lowther	U.S. 4,965,052	Oct. 23, 1990
Bromberg	U.S. 5,409,784	Apr. 25, 1995
Dickey	U.S. 5,832,880	Nov. 10, 1998
Britton	U.S. 6,314,925 B1	Nov. 13, 2001
Dahung Hsu <sup>2</sup>	EP 643,209 A1	Mar. 15, 1995

#### The Claimed Subject Matter

The claimed subject matter is directed to a compression ignition engine that concurrently initiates the injection of fuel and the injection of an acetylene-based component into the engine. Independent claim 1 is illustrative of the claims on appeal and is reproduced below:

1 . A method of operating a homogeneous-charge compression ignition (HCCI) engine, comprising:  
initiating fuel injection and concurrently initiating injection of an acetylene-based-component into said engine;  
mixing air, said fuel and said acetylene-based component to form a combustion mixture; and

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<sup>1</sup> Claims 18, 19 and 36 are only objected to and will not be addressed herein (Final Office Action p. 8).

<sup>2</sup> EP 643,209 A1 lists the last name as “Dahung Hsu” but the Examiner and Appellants only employ “Dahung” and we will likewise identify this reference as “Dahung” to maintain consistency.

compressing said combustion mixture to induce auto-ignition of said combustion mixture, releasing energy and converting said combustion mixture to exhaust gas.

### The Rejections on Appeal

Multiple corrective Examiner Answers have been mailed in this appeal. The last one, mailed Nov. 7, 2007, is cited herein.

1. Claims 1, 2, 8-14, 17, 20, 24-28, 34 and 35 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dahung in view of Bundrick and further in view of Gonzalez (Ans. 3).
2. Claims 3, 15 and 29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Britton (Ans. 6).
3. Claims 4, 16, 30-32 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Dickey (Ans. 7).
4. Claims 5, 6, 21, 22 and 33 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Bromberg (Ans. 8).
5. Claims 7 and 23 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Ethington (Ans. 8).
6. Claims 7 and 23 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Lowther (Ans. 9).

## ISSUE

Has the Examiner established that one of ordinary skill in the art would have had reason to concurrently initiate the injection of a fuel and an acetylene-based component into a compression ignition engine when it was known that multiple fuels can each be injected into a compression engine and that acetylene is an available fuel for compression ignition?

## FINDINGS OF FACT

1. Dahung discloses a dual-fuel compression engine where a main fuel and a pilot fuel are each injected into the combustion chamber (Dahung 2:30-35, Fig. 1 and Abst.).
2. Dahung teaches that “More than 65 years ago it was recognized that a small amount of readily ignitable pilot fuel could be injected in diesel engines to improve combustion of ‘heavy’ hydrocarbon fuels that are otherwise difficult to ignite” (Dahung 2:7-11).
3. Dahung teaches that pilot fuel “is more readily flammable than the main fuel”, that pilot fuel “serves to ignite the main fuel” and that “other readily combustible pilot fuels may also be used” (Dahung Abst. and 5:19-30).
4. Dahung further teaches that “the injection timings and quantities can be varied” (Dahung 5:19-21).
5. Gonzalez discloses an internal combustion engine that is operable in “a non-assisted compression ignition (diesel) mode” and that “[p]ilot and main fuel injections timings may be concurrent or staged” (Gonzalez 1:59-64, 2:67-68).

6. Bundrick discloses a compression-ignition engine and lists acetylene as “an available fluid fuel” (Bundrick 2:15-18).

### ANALYSIS

Appellants separately argue each of the Examiner’s rejections and each reference cited, and Appellants present different arguments for different claim groupings (App. Br. 7-13, Reply Br. (mailed Aug. 21, 2006) 2-12, and Supp. Reply Br. (mailed Jan 22, 2007) 1-3). Each of these will be addressed below.

In general, and with respect to all the claims, Appellants contend that there is no motivation to combine the references (App. Br. 7-13, Reply Br. 2-12). However, the Examiner’s stated motivation is “to enhance the engine performance” (Ans. 4) and this is consistent with Dahung’s desire “to improve combustion” by combining a readily ignitable pilot fuel with the main diesel fuel (Dahung 2:7-11). Bundrick’s teaching that acetylene is a readily available fuel for use in compression ignition engines, i.e., diesel engines (Bundrick 2:15-18) and Gonzalez’s teaching that both a main and a pilot fuel can be added concurrently to the firing chamber (Gonzalez 2:67-68) would have been known to one skilled in the art seeking to improve the combustion of a diesel engine. Hence, the Examiner has provided sufficient reasons to combine the teachings of Dahung, Bundrick and Gonzalez.

*Rejection 1: The Subject Matter of Claims 1, 2, 8-14, 17, 20, 24-28, 34 and 35 are Obvious over Dahung, Bundrick and Gonzalez.*

Method claims 1, 2, 8-14, 17, 20, 24-26 and apparatus claims 27, 28, 34 and 35 are rejected by the Examiner as being obvious over Dahung,

Bundrick and Gonzalez (Ans. 3). Each independent claim (claims 1, 13 and 27) requires the *concurrent initiation of the injection* of a fuel and an acetylene-based component into an engine.

Dahung teaches that a pilot fuel could be injected into a diesel engine “to improve combustion” of the more-difficult-to-ignite main fuel (Dahung 2:7-11). Dahung further teaches that “[o]ther readily combustible pilot fuels may also be used” and that “[t]he injection timings and quantities can be varied” (Dahung 5:19-30). Bundrick lists acetylene as “an available fluid fuel” for compression ignition (Bundrick 2:15-18) and Gonzalez specifically teaches that “[p]ilot and main fuel injections timings *may be concurrent* or staged” (italics added) (Gonzalez 1:59-64, 2:67-68).

Specifically addressing independent claims 1 and 13, Appellants present arguments directed to deficiencies in the individual references which the Examiner had already acknowledged (Ans. 4, App. Br. 7, *see also* Reply Br. 5-6). Appellants also present arguments directed to teachings in the references upon which the Examiner does not rely (App. Br. 7-9, *see also* Reply Br. 4 and 8-11). These arguments are not deemed persuasive.

Appellants also contend that Dahung, Bundrick and Gonzalez “do not suggest or provide the necessary motivation to arrive at the invention as claimed” and, more specifically, that Dahung does not teach the claimed invention; that “Bundrick fails to cure the deficient teachings of Dahung” and that “Gonzalez also fails to cure the deficient teachings of Dahung” (App. Br. 7-8, Reply Br. 2). An express teaching or motivation in the references is not required; instead, the Examiner need only articulate a reason to combine the references with some rational underpinning to support the legal conclusion of obviousness (*see KSR Int’l Co. v. Teleflex Inc.*, 550

U.S. 398, 418 (2007)). The Examiner's stated reason is "in order to enhance the engine performance" (Ans. 4) which is consistent with Dahung's desire "to improve combustion" (Dahung 2:7-11). Appellants contend that Bundrick fails to cure the deficiencies of Dahung on the basis that Bundrick fails to teach multiple fuels or concurrent injection of multiple fuels (App. Br. 7-8). Appellants also contend that Gonzalez fails to cure the deficiencies of Dahung on the basis that Gonzalez is directed toward a spark-ignition engine that separately combusts the fuels and does not create a combustion mixture (App. Br. 8-9). However, the Examiner does not rely on Bundrick or Gonzalez for these teachings. Thus, Appellants' arguments are not persuasive.

Appellants specifically address independent apparatus claim 27 which requires a first amount of fuel and a second amount of acetylene-based component be supplied to a reciprocally driven cylinder which also receives a third amount of air (App. Br. 9-10). Appellants repeat the allegations that Dahung fails to teach this, that "Bundrick fails to cure the deficient teaching of Dahung" and that "Gonzalez further fails to cure the deficient teachings of Dahung" (App. Br. 10). Again, Appellants do not collectively address all three references or the Examiner's position as to what this combined trio teaches. Nevertheless, Dahung clearly states that "The injection timings *and quantities* can be varied" (*italics added*) (Dahung 5:19-21). Because Dahung teaches that the quantity of the pilot and main fuel injected into the cylinder's combustion chamber can vary, Appellants' argument that "claim 27 defines over the prior art" is not persuasive (App. Br. 10).

In addressing all three independent claims 1, 13 and 27, Appellants allege that "the Examiner incorrectly relies on the general knowledge of one



skilled in the art to combine the references” (App. Br. 10). This contention is not persuasive because the Examiner relied upon the combined teachings of Dahung, Bundrick and Gonzalez and the Examiner’s reason for their combination mirrors Dahung’s recitation of a desire “to improve combustion” (Dahung 2:7-11). More specifically, the Examiner’s stated reason, i.e. “in order to enhance the engine performance” (Ans. 4), is achieved by the Examiner’s combination of Dahung’s dual fuel engine with Bundrick’s teaching regarding “the use of acetylene in the compression ignition” and also Gonzalez’s teaching of “concurrent” pilot and main injection timings (Ans. 4). Accordingly, Appellants’ contention that the Examiner incorrectly relied on the general knowledge of one skilled in the art is unsupported (App. Br. 10-11).

Appellants further allege that Dahung “teaches away” from concurrently injecting both a fuel and an acetylene-based component into the engine because Dahung’s does so in stages (Reply Br. 5-6). Our reviewing court has stated “[t]he prior art’s mere disclosure of more than one alternative does not constitute a teaching away from any of these alternatives because such disclosure *does not criticize, discredit, or otherwise discourage* the solution claimed”. *In re Fulton*, 391 F.3d 1195, 1201 (Fed. Cir. 2004) (emphasis added). Appellants provide no evidence of Dahung criticizing, discrediting or otherwise discouraging the claimed solution and thus Appellants’ contention is not persuasive.

When specifically addressing Bundrick, Appellants contend that “[o]ne of skill in the art would not look to a reference listing ‘available’ surplus fuels that can potentially be combusted in a flex-fuel engine to select a combination of fuel and additive for a sophisticated and highly calibrated

HCCI engine” (Reply Br. 7). Appellants’ argument is not supported by objective evidence because Appellants failed to set forth any affidavits or declarations in support of that assertion. *See In re Pearson*, 494 F.2d 1399, 1405 (CCPA 1974) (Appellants’ arguments do not take the place of evidence); *see also In re Geisler*, 116 F.3d 1465, 1470 (Fed. Cir. 1997); *In re De Blauwe*, 736 F.2d 699, 705 (Fed. Cir. 1984) (lawyer arguments and conclusory statements which are unsupported by factual evidence are entitled to little probative value).

When specifically addressing Gonzalez, Appellants do not dispute that Gonzalez teaches a “non-assisted compression ignition (diesel) mode” (Reply Br. 8 *citing* Gonzalez 1:61-65). However, Appellants contend that a general statement by the Examiner “to ‘enhance engine performance’ is not borne out by what Gonzalez teaches” (Reply Br. 8). More specifically, Appellants allege that Gonzalez “teaches away” from using concurrent injection of pilot and main fuels in high compression engines and Appellants assert that the claimed HCCI engines “are relatively high compression engines” (Reply Br. 8-9). Appellants assert that Gonzalez “teaches away” due to the statement in Gonzalez that “[t]he timing of main fuel injection *may* be concurrent with the pilot fuel injection on engines of low specific output or low compression” (italics added) (Reply Br. 8-9; Gonzalez 5-68 to 6:3). Appellants have not shown how this disclosure in Gonzalez criticizes, discredits or otherwise discourages concurrent injection of pilot and main fuel in a high compression engine (*See Fulton*, 391 F.3d at 1201). Accordingly, Appellants’ contention is not persuasive.

Appellants also contend that “one of skill in the art would not look to the limited class of pilot fuels used to ignite an otherwise non-ignitable fuel

for improving performance in an HCCI engine, which uses a pre-mixed self-ignitable fuel” (Reply Br. 6, *see also* Reply Br. 7). The references cited by the Examiner state otherwise. Dahung teaches that “[m]ore than 65 years ago it was recognized that a small amount or readily ignitable pilot fuel could be injected in diesel engines to improve combustion of ‘heavy’ hydrocarbon fuels that are otherwise difficult to ignite” (Dahung 2:7-11). Bundrick lists acetylene as “an available fluid fuel” for compression ignition (Bundrick 2:15-18). In view of the above teachings, and contrary to Appellants’ contention, one skilled in the art would have been led to the use of acetylene as part of a pre-mixed self-ignitable fuel, especially when it has been known for more than 65 years that a readily ignitable pilot fuel could be injected in a diesel engine along with a more difficult to ignite fuel.

In specifically addressing dependent claims 17, 20 and 35 “regarding the variation in load conditions,” Appellants allege that Dahung “does not specify varying the amount of pilot fuel” nor does Dahung “suggest modifying the quantity of pilot fuel to the engine” (Reply Br. 6). This is incorrect as Dahung specifically teaches that “[t]he injection timings *and quantities* can be varied” (*italics added*) (Dahung 5:19-21). Appellants’ contention is not persuasive.

In specifically addressing dependent claims 10, 11, 26 and 34, Appellants contend “[t]hese claims specifically recite ranges” and “a proper rejection must point to at least some reference having a mixture of acetylene-based component and fuel within the ranges set forth” (Reply Br. 11). Appellants state that the Examiner “is utilizing hindsight construction” because the Examiner has provided no support for the combination of Dahung, Bundrick and Gonzalez and that these references “lack any mention

of ranges based on stoichiometry of the acetylene-based compound” (Reply Br. 12, Supp. Reply Br. 2). The Examiner rejected these claims asserting that it would have been obvious “to optimize the proportions of the fuel based on the loading requirement of the engine” because “discovering the optimum or workable ranges involves only routine skill in the art” (Ans. 12 referencing *In re Aller*, 105 USPQ 233). Appellants dispute whether *Aller* applies because “there is no single reference here that teaches a claimed method; there are no example methods laid out in the prior art with given parameters” and there is “no starting point for the automotive engineer to optimize” (Supp. Reply Br. 2). Appellants also contend that Dahung teaches using a pilot fuel to ignite a main fuel that “*cannot* be self-ignited” and that this reference teaches “a pilot fuel is needed [for] fuel that *does not* self-ignite” (italics added) (Supp. Reply Br. 2-3). Appellants contend that “one would not use a pilot fuel if the main fuel self-ignited” (Supp. Reply Br. 2).

Dahung does not address use of a main fuel that “cannot” or “does not” self-ignite as asserted by Appellants, instead, Dahung addresses main fuels “that are otherwise difficult to ignite” (Dahung 2:7-11, *see also* Abst (“a pilot fuel (14) which is more readily flammable than the main fuel”), and Dahung 2:33-35 (“one of the fuels is a pilot fuel which burns more readily than the other fuel, which is the main fuel”)). Dahung specifically teaches that it has been known for more than 65 years that a “readily ignitable pilot fuel could be injected in diesel engines to improve combustion of [main] fuels that are otherwise difficult to ignite” (Dahung 2:7-11). Dahung further teaches one example where pilot fuel in the amount of “about 4% to about 7% by energy is injected through the pilot injector 14 to provide an ignition source for the gas fuel” (Dahung 5:25-28). Hence, contrary to Appellants’

assertions as to why *Aller* does not apply in the present situation, Dahung is a single reference that, modified in accordance with Bundrick and Gonzalez as above, teaches the claimed method and provides a specific example with given parameters as a starting point for the automotive engineer to optimize. Accordingly, Appellants' assertions are not persuasive and there is no evidence that the Examiner relied upon hindsight.

Based on the record before us, the Examiner's rejection of claims 1, 2, 8-14, 17, 20, 24-28, 34 and 35 as being unpatentable over Dahung, Bundrick and Gonzalez is sustained.

*Rejection 2: The Subject Matter of Claims 3, 15 and 29 are Obvious over Dahung, Bundrick and Gonzalez and further in view of Britton.*

Appellants contend that it is unclear how Britton's acknowledged teaching of hydrogen and acetylene as a fuel "could suggest to a skilled artisan that these compounds in particular should be used as an additive component for fuels in an HCCI engine" (Reply Br. 10). The Examiner specifically addressed this matter by referencing the passage in Britton stating "[f]uels such as hydrogen and acetylene with lightweight molecules exhibit higher flame speed and less ignition delay" as the reason why such fuel would be employed would be "in order to improve the combustion process" (Ans. 7 *citing* Britton 8:22-24). Appellants present no further argument different from those already advanced above other than to state that claims 3, 15 and 29 depend from one of the claims previously addressed and that these three claims "define over the prior art for at least the reasons stated above" (App. Br. 11, Reply Br. 10). As the Examiner's rejections of

the earlier claims were sustained, we likewise sustain the Examiner's rejection of claims 3, 15 and 29 for the same reasons.

*Rejection 3: The Subject Matter of Claims 4, 16, 30-32 is Obvious over Dahung, Bundrick and Gonzalez and further in view of Dickey.*

Appellants contend that Dickey "provides no motivation to include an acetylene-based component" and that Dickey provides no suggestion for "concurrently" initiating the injection of this component with a separate fuel (Reply Br. 9-10). The Examiner did not rely upon Dickey for these reasons but instead for Dickey's teaching of a diesel engine having an exhaust gas recirculation system that diverts some of the exhaust gas back to the intake manifold (Ans. 7, *see also* Dickey 4:10-13 and Fig. 1). As Appellants have made no other argument different from those already advanced, we sustain the Examiner's rejection of claims 4, 16, 30-32 for the same reasons.

*Rejection 4: The Subject Matter of Claims 5, 6, 21, 22 and 33 are Obvious over Dahung, Bundrick and Gonzalez and further in view of Bromberg.*

Appellants contend that "while Bromberg states that a plasma reformer can generate acetylene and hydrogen, there still remains no suggestion to employ this combination of a fuel and an additive component in an HCCI engine system" (Reply Br. 11). Bromberg discloses the technique of employing a plasmatron to generate acetylene in an automotive environment (Bromberg 9:28-29, 10:41-42 and Figs. 11 and 17). It is well settled that the use of a known technique to improve a similar device in the same way is obvious unless its actual application is beyond the ability of one skilled in the art (*KSR Int'l Co. v. Teleflex, Inc.* 550 U.S. 398, 417 (2007)).

Appellants have not shown that it would be beyond the ability of one skilled in the art to improve the combination of Dahung, Bundrick and Gonzalez with Bromberg's teaching of generating acetylene for use as an engine fuel. Accordingly, we sustain the Examiner's rejection of claims 5, 6, 21, 22 and 33 for these reasons and for the reasons set forth above.

*Rejections 5 and 6: The Subject Matter of Claims 7 and 23 are rejected as being Obvious over Dahung, Bundrick and Gonzalez and further in view of Ethington or, alternatively, and further in view of Lowther.*

Appellants contend that neither of these references provide the requisite "suggestion or motivation" and hence the "presently claimed invention is non-obvious and patentable" (Reply Br. 11). Appellants' arguments regarding these references cite teachings different from the teachings relied upon by the Examiner (Reply Br. 11, Ans. 8-10). As Appellants have made no other argument different from those already advanced above, we sustain the Examiner's rejection of claims 7 and 23 for the same reasons.

### CONCLUSION OF LAW

The Examiner has established that one of ordinary skill in the art would have had reason to concurrently initiate the injection of a fuel and an acetylene-based component into a compression ignition engine when it was known that multiple fuels can each be injected into a compression engine and that acetylene is an available fuel for compression ignition.

DECISION

1. The rejection of claims 1, 2, 8-14, 17, 20, 24-28, 34 and 35 as being unpatentable under 35 U.S.C. § 103(a) over Dahung in view of Bundrick and further in view of Gonzalez is affirmed.
2. The rejection of claims 3, 15 and 29 under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Britton is affirmed.
3. The rejection of claims 4, 16, 30-32 under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Dickey is affirmed.
4. The rejection of claims 5, 6, 21, 22 and 33 under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Bromberg is affirmed.
5. The rejection of claims 7 and 23 under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Ethington is affirmed.
6. The rejection of claims 7 and 23 under 35 U.S.C. § 103(a) as being unpatentable over Dahung, Bundrick and Gonzalez and further in view of Lowther is affirmed.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

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